



Isolating a Measure of Inflation Expectations for the South African Financial Market Using Forward Interest Rates

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Abstract

The inflation expectations channel of the transmission mechanism has generally become recognised as crucial for the implementation of modern monetary policy. This paper briefly reviews the practices commonly employed for measuring inflation expectations in South Africa and offers a market-based alternative with advantages over existing measures. It is widely recognised that the yield curve contains some information about the future inflation expected by the markets. The availability of inflation-indexed bonds in South Africa for the past few years has provided an opportunity to use more recently developed techniques for isolating a measure of inflation expectations using the difference between nominal and real forward interest rates (inflation compensation). In this paper, the methodologies of Nelson and Siegel (1987) and Svensson (1994) are applied in order to determine a series of implied nominal and real forward interest rates. The difference between the nominal and real forward rates on a particular day are then determined, and this is used as a measure of the inflation expectations of the markets. This measure of inflation expectations should not be viewed as a substitute for other measures of inflation expectations, but should rather supplement these in order to offer an additional insight.

1 Introduction

The South African inflation targeting regime is facing its greatest challenge since its implementation in 2000, and the state of the inflation expectations of the population are central to the defence of the regime. Modern monetary authorities are increasingly relying on the expectations channel of the transmission mechanism to implement monetary policy, and inflation targeting is used as a framework to manage these expectations. Therefore, the measurement of inflation expectations is crucial to empirical work that attempts to understand the transmission of monetary policy and improve its efficiency, and it is central to the debate surrounding the appropriateness of inflation targeting in the South African context.

Some of the methods currently used as measures of inflation expectations will be presented in section 2, followed in section 3 by a discussion of the merits of ‘forward inflation compensation’ (the difference between the nominal and real forward rates) as a measure. It is recognised that the term structure of interest rates, which is represented graphically by the yield curve, contains information about the inflation expectations of the financial markets. The difficulty lies in disentangling the information about inflation expectations contained in the yield curve from the other information, including expected real future interest rates and risk premia.

Calculating the implied forward rates necessary to determine forward inflation compensation is also a challenge. The method proposed in this paper for calculating these forward rates will

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be explained in section 4, and then the actual extraction of the South African implied forward rates, using the parametric methodologies of Nelson and Siegel (1987) and Svensson (1994), will be demonstrated in section 5. The South African inflation compensation series that is finally extracted will be analysed in section 6.

2 Measures of South African Inflation Expectations

The South African Reserve Bank's (SARB) mandate is 'to protect the value of the currency of the Republic in the interest of balanced and sustainable growth in the Republic' (South African Reserve Bank Act 90 of 1989, amended: 3). In line with received wisdom about the goals of monetary policy (Walsh, 2003) and the vital role of managing private sector expectations, the SARB aims to anchor inflation expectations in order to minimise output costs, while pursuing *low* and *stable* inflation. Through increased transparency and credibility, the central bank can enhance the predictability of its actions and encourage the transmission of changes in the monetary authority's interest rate along the yield curve to long-term interest rates, which influence the majority of economic decisions.

According to Aron and Muellbauer (2006: abstract), the move to inflation targeting has enhanced the credibility and efficiency of monetary policy in South Africa, and delivered 'reasonable predictability'. There is no one perfect or conclusive method for measuring these concepts, but a number of measures can be used to give us an indication of the degree of success of monetary policy in anchoring inflation expectations in order to achieve the goals of low, stable prices, and sustainable economic growth.

Visual inspection of graphical representations of the evolution of various macroeconomic indicators (including a widely used survey based measure of inflation expectations) can offer some valuable insights.

Figure I

Figure I shows that over the period 2002 to mid-2007, CPIX inflation and inflation expectations decreased in South Africa, while GDP growth rose and the repo rate was lowered. In 2002, the repo rate was raised in an attempt to contain sharp increases in inflation and inflation expectations, and output decreased. More recently, GDP growth was able to rise strongly with limited increases in inflation and inflation expectations. Although successful monetary policy would wish to achieve these types of trends, they could merely be what Aron and Muellbauer (2006) call a 'lucky accident'.

The measurement of inflation expectations and credibility of the central bank are areas in need of further research in order to more rigorously evaluate the degree to which modern monetary policy succeeds in influencing interest rates (especially over longer horizons). In the November 2006 Monetary Policy Review, three measures of inflation expectations in South Africa were identified – the inflation expectations surveys of the Bureau of Economic Research (BER), the Reuters Survey and breakeven inflation expectations. Firstly, the BER conducts a survey of the inflation expectations among financial analysts, business executives, trade unions and households on a quarterly basis, which has added valuable insight by evaluating the expectations of these different groups separately (Kershoff and Smit (2001), Kershoff (2000)).

The second measure of inflation expectations referred to in the Monetary Policy Review was the Reuters Survey. In this survey, a panel of professional economists are asked, on a monthly basis, for their forecast of the quarter-end values of a set of economic indicators¹. This is a useful way of testing the robustness of the one component of the BER survey (the financial analysts).

Survey measures such as these, offer a subjective approach to the measurement of inflation expectations. They offer advantages such as potentially valuable insights into expectations of different groups, but they do have a number of limitations. It is unlikely that the respondents would answer

¹For three months economists forecast the same upcoming quarter end, so their forecast horizon shortens progressively.

the survey questions with an equal level of commitment as they would dedicate to making investment decisions which have financial implications for them or their companies. In addition, survey data aggregates forecasts of the various respondents who have each formed these forecasts based on different models and contingent scenarios of the world. Averaging the output of different models can be uninformative, especially if the averaging is not weighted for the quality of the individual forecasts.

Both the BER survey and the Reuters survey are conducted on a monthly basis, which limits their suitability for investigating higher frequency events. Many factors change over the course of a month and events take place that have a bearing on the formation of inflation expectations, so a higher frequency measure of inflation expectations offers great potential to differentiate the effects of each of these changes on inflation expectations.

The third indicator of inflation expectations referred to in the Monetary Policy Review was the breakeven inflation rates (the difference between the yields on nominal and inflation-indexed bonds). Establishing a market-based measure of inflation expectations is appealing from the point of view that it would address the concerns raised about the survey data. Additionally, it is more accurate and available at a high frequency (Svensson and Söderlind, 1997). Based on the Fischer equation, bond yields are recognised as containing information about inflation expectations. The Fischer equation below decomposes the nominal interest rate into inflation expectations and the real interest rate (Söderlind, 1995).

$$i_t = r_t + \pi_t^e \tag{1}$$

where i_t = nominal interest rate

r_t = real interest rate

π_t^e = inflation expectations

It is now quite common to extract ‘breakeven inflation’ as a proxy for the inflation expectations of the market². A disadvantage of the breakeven inflation rates is that a single nominal bond is compared with a single inflation indexed bond but the maturities of these instruments are imprecisely matched. In addition, breakeven rates calculated using the same bonds at different points in time are not easily comparable, especially if the time period between the two observations is substantial, as the maturities of the bonds would have decreased over the period. The liquidity risk premium demanded for the bonds will decrease as their maturities decrease, complicating inferences about inflation expectations using these breakeven inflation rates.

It is often preferable to describe the interest rate as a forward rate rather than as a yield (the reasons for this will be presented in the following section). Breakeven rates are quoted as yields and although it is relatively easy to obtain the spot rates and forward rates for the nominal bonds, these are not readily available for the indexed bonds. The forward inflation compensation measure presented in the following section is an extension of market-based breakeven inflation rates, which use forward rates over the entire yield curve and address some of the other shortcomings of the alternative measures of inflation expectations discussed.

3 Forward Inflation Compensation³ as a Measure of Inflation Expectations

It is widely recognised that the yield curve (the term structure of interest rates) contains information about the market’s expectations of the path of future inflation, together with information about the expected path of future real interest rates and risk premia. Based on the Fisher equation (equation 1),

²Some of the banks in South Africa are currently developing interest swap rates, which will offer an alternative measure of inflation expectations in future. However, these have only been trading for a short period, so the series is not yet long enough to be used for much robust econometric evaluation.

³Terminology used by Gurkaynack, Sack and Swanson, 2005

inflation expectations can be extracted by finding the difference between nominal and real interest rates (Walsh, 2003). In addition, the capital asset pricing model recognises that together with information about inflation expectations, at a long horizon, the yield curve also contains information about the real interest rate and risk premia. It would be ideal to isolate the expected inflation by identifying the real interest rates and the risk premia and removing their influences as well, but this is not simple in practice.

Studies using the *term structure of interest rates*⁴ often assume that the expectations hypothesis holds – ‘the n -period interest rate equals an average of the current short-term rate and the future short-term rates expected to hold over the n -period horizon’ (Walsh, 2003: 489), or that the term premia are negligible and treated as if it were zero. This is a contentious issue with many conflicting findings (see Berk (1998) for a summary of some of these conflicting empirical findings). Svensson (1994) argues that forward interest rates may still act as indicators of inflation expectations because the risk premia that have been estimated have been small and they vary at low frequencies, so analysis of shifts in the yield curves at daily frequencies remain informative about changes in high frequency inflation expectations. Not much of the change in the slow moving risk premia could be attributed to single day, so this would not theoretically be responsible for much of the variation of the interest rate on a single day. In conclusion, although this measure is a useful indicator of the market’s inflation expectations, it is not advisable to rely solely on the forward curve information to assess market inflation expectations (Svensson, 1994).

The yield curve, spot rate (zero-coupon) curve and forward rate curves are different representations of the same term structure information, based on the same underlying financial instruments (Coleman, 1998), but they present this information in different forms which are useful for different purposes. Svensson (1994) proposed the use of forward interest rates as a measure of market expectations because they represent the expected short-term interest rate for a future period of time along the time path of interest rates, and it is easier to separate short-, medium- and long-term expected interest rates. The one-year forward rate, ending in ten years time, is the short-term forward rate between years nine and ten. He compares the relationship between the yield curve and the forward interest rate curve to that between the average and marginal cost curves. A point on the yield curve at a long horizon represents an average of all the expected changes in the components up till that point, whereas the forward interest rate at that horizon reflects only the marginal or short-term interest rate at that horizon. It is therefore easier to interpret expected future short-term interest rates (and inflation expectations as a component of this) by tracking the evolution of forward interest rates over time.

If it is possible to determine both the real and nominal forward interest rates, forward inflation compensation (the difference between nominal and real forward rates) can be determined, which will provide a measure (albeit an imprecise measure) of inflation expectations. For example, the one-year forward inflation compensation, ending in ten years time would provide a proxy for inflation expectations between the end of year nine and the end of year ten.

$$Fwdinflationcompensation(9 - 10) = nomfwdrate(9 - 10) - realfwdrate(9 - 10)(2) \quad (2)$$

The determination of this forward inflation compensation measure therefore requires nominal and real forward rates. Forward rate agreements are explicit forward rates, determined by market trading, but in South Africa, they are only available for shorter time horizons, and so they do not offer an indication of short-term interest rates over the long-term future, which is of particular interest in judging whether inflation expectations are well anchored⁵. Instead implied forward rates must be extracted from yield curve data.

⁴The term structure of interest rates (usually illustrated by a yield curve) describes the relationship between interest rates and term to maturity

⁵Expectations are well ‘anchored’ if they are strongly influenced by the nominal anchor (e.g. the inflation target) rather than being buffeted by current economic developments

4 Extracting Implied Forward Rates

The implied forward rate could be calculated from the price of a zero-coupon bond, based on the following relationship (Anderson and Sleath, 2001):

$$B(\tau) = \exp \left[- \int_0^{\tau} f(m) dm \right] \quad (3)$$

where $B(\tau)$ is the price of a τ -maturity zero-coupon bond

$f(m)$ is the ‘instantaneous’ forward rate (the rate for which the ‘difference between settlement time and maturity time approaches zero’ (Bank for International Settlements, 2005: v))

However, zero-coupon bond prices are usually not freely available from the market for a full range of maturities along the curve (where they are available they are usually for horizons under one year). Instead, the zero-coupon price must in turn be extracted from the prices of the available (observable) coupon-bearing bonds, where the bond price and the price of the zero-coupon bond are related in the following manner (Anderson and Sleath, 2001):

$$P(c_i, \tau_i, i = 1, \dots, n) = \sum_{i=1}^{n-1} c_i B(\tau_i) \quad (4)$$

where P is the price of the observable coupon-bearing bond

c_i is the coupon payment

τ_i is the maturity of the bond

n is the number of coupon payments outstanding

B is the price of a zero-coupon bond

Therefore, using equations (2) and (3) above, it is possible to determine the forward rate from the price of observable coupon-bearing bonds. The prices of the coupon bonds, the coupon rates and the time to maturity of the bonds are used to determine the price of the zero-coupon bond (equation (3)). Then the price of the zero-coupon bond can be used to calculate the instantaneous forward rates (equation (2)).

The next challenge is that these bonds are not available for every maturity along the curve (Anderson and Sleath, 2001) i.e. the calculation above determines the forward rate at a single point in time. A method is required to interpolate and trace the full curve. The approaches available to determine the zero-coupon and forward rate curves implied by the bond data can broadly be divided into parametric methods and spline-based methods. Both these approaches determine a set of parameters to describe the entire zero-coupon and forward rate curve implied by the bond data (Anderson and Sleath, 2001), but the two methods by which they achieve this each offers different advantages.

Three criteria are used to compare the relative advantages of the different approaches to determining the functional form and estimation of these parameters (Anderson and Sleath, 2001). Ideally, the curve should be *flexible* enough to capture the changes in the interest rates at different horizons (especially at the short-end, where there tends to be greater curvature), but should not excessively compromise *smoothness* by insisting on passing through every data point. The *stability* of the forward rate curve should also not be excessively influenced by the minor adjustments of a single (or a small number of) bond data points.

By using a simple function, with few parameters to estimate, the parametric models offer a parsimonious, simple and robust method of estimating forward rates. They tend to offer a smoother curve with less flexibility, although the inclusion of additional terms in the functional form can increase their flexibility.

By contrast, spline-based methods determine a segmented curve, where the individual segments are represented by cubic polynomials which are joined at knot points (Anderson and Sleath, 2001).

The parameters of these segments are restricted to maintain a continuous curve, but they do allow a greater level of flexibility as they are able to move more independently. For the purposes of monetary policy, an unconstrained spline can compromise smoothness in an excessive manner as it becomes increasingly flexible, therefore modified versions (such as the Fisher, Nychk and Zervos (1995) or the variable roughness penalty parameter methods (Waggoner, 1997)) are more commonly used for this purpose.

In this paper, the parametric models of Nelson and Siegel (1987) and Svensson (1994) are used. According to Svensson (1994), the simple parametric model of Nelson and Siegel (together with Svensson’s extension) offers sufficient precision for the purposes of monetary policy. This is also widely used by international central banks (Bank of International Settlements, 2005), so adopting the same method is useful for comparative purposes.

Nelson and Siegel (1987) used a relatively simple functional form to estimate a parsimonious forward rate curve.

$$f(m; \beta) = \beta_0 + \beta_1 \exp\left(-\frac{m}{\tau_1}\right) + \beta_2 \frac{m}{\tau_1} \exp\left(-\frac{m}{\tau_1}\right) \quad (5)$$

where f is the instantaneous forward rate curve

β is the vector of parameters to be estimated

m is the time to maturity

τ is the maturity of the bond

The first term captures the horizontal asymptote of the curve (the level) and the second term is an exponential function that increases or decreases monotonically (depending on the sign of the coefficient) towards zero as the time to maturity approaches infinity (the slope of the curve). The third term determines the hump or U-shape of the curve (the curvature), depending on whether the coefficient is positive or negative (Diebold and Li, 2006, Söderlind and Svensson, 1996).

Svensson (1994) extended Nelson and Siegel’s function by adding an additional term, which increased the flexibility of the model.

$$f(m; \beta) = \beta_0 + \beta_1 \exp\left(-\frac{m}{\tau_1}\right) + \beta_2 \frac{m}{\tau_1} \exp\left(-\frac{m}{\tau_1}\right) + \beta_3 \frac{m}{\tau_2} \exp\left(-\frac{m}{\tau_2}\right) \quad (6)$$

This functional form is used to estimate a set of bond prices. Maximum likelihood is then used to estimate parameters that will minimise the sum of the squared yield errors or price errors (the difference between the observed and estimated yields or prices) (Svensson, 1994, Anderson and Sleath, 2001). Svensson (1994) argues that it is more appropriate to minimise the yield errors in this case as communication about monetary policy relies on interest rates, and prices are less sensitive to changes in yields at the short end of the curve, which can result in large yield errors.

Both the nominal and real implied forward rate curves had to be calculated in order to determine the forward inflation compensation (the difference between the nominal and real forward interest rates).

5 Implied Forward Rates for South Africa

South Africa does not have many inflation-linked (real) bonds. Neither real forward interest rates, nor the real zero-coupon curve were available for South Africa. Many researchers facing this problem have made the assumption that the real interest rates far in the future are constant, and therefore all the variations in the long-term nominal interest rates are due to changes in inflation expectations (Walsh, 2003). Empirical evaluations of the markets have widely (but not unanimously) indicated that at longer horizons, real interest rates are far more stable and the movement in nominal interest rates tends to reflect mainly changes in inflation expectations (Walsh (2003), Ang, Bekaert, and Wei (2007)). Ang, Bekaert and Wei (2007) find that 80% of the variation in the nominal interest rate in the US at the 20-quarter horizon is due to the variation in inflation compensation (inflation

premium and expected inflation), and inflation expectations are responsible for most of the nominal rate spread.

Figure II shows a strong correlation between the overnight interest rate and CPIX in South Africa. The correlation between CPIX and the R153 (a nominal government bond maturing on 31 Aug 2010) is not as strong but is certainly not unrelated. During the period where inflation peaked, the R153 dropped below CPIX, which corresponds with other measures of inflation expectations which show that inflation expectations lay below actual inflation during this period.

Figure II

Although there does appear to be reason to believe that the real interest rates are relatively constant far into the future, this kind of assumption is rarely made with confidence, especially when investigating a developing country, because most of the assumptions are based on studies of more developed countries.

Instead, in this study, the methodologies of Nelson and Siegel, and Svensson (Svensson, 1994) were adopted to calculate implied forward rates from bond data.^{6 7} To determine the forward interest rate on a particular day, the yields to maturity, time to maturity and coupons of a set of bonds, recorded by the markets on that day, are required as inputs. From these, a zero-coupon yield curve (spot rate curve) and a forward rate curve for that day can be estimated.

For the nominal forward rate curves, between four and seven nominal government bonds⁸ were available concurrently over the sample period. The SARB overnight rate and the 91-day, 182-day and 273-day Treasury Bills were added as inputs to help define the curves at the short end. Figure III is a typical example of the nominal curves plotted by the programme. The estimated yield to maturity is represented by the dots and the observed yield to maturity by the squares, so where the dot lies within the square the squared yield error is small.

Figure III

For real forward rate curves, three inflation-indexed government bonds were available concurrently from 26 April 2002. A fourth was added from 15 August 2003⁹. The SARB overnight rate and the three Treasury Bills were adjusted for inflation expectations and used to trace the short ends of the curves. The Reuters Econometer forecasts of inflation were used to adjust these short-term instruments, because it is a measure of the inflation expectations of the financial market ‘audience’ in particular, and the survey does include the markets’ forecasts one, two and three quarters ahead, so these can be appropriately matched with the horizons of the three Treasury Bills.

A series of these forward rate curves calculated for each day corresponding to the recorded surprises is useful to observe the changes in inflation expectations of the markets over time.¹⁰ The sample period was May 2002 to June 2008, limited by the date from which sufficient inflation-indexed bonds were available. Of the 334 weekly observations, approximately 4% of the real curves were excluded from the regression analysis due to the inability of the algorithm to find stable parameter

⁶After an article by Svensson and Soderlind (1997), Soderlind made the Matlab code for Svensson’s method available on his website. (<http://home.datacomm.ch/paulsoderlind/>).

⁷Zero-coupon yield curves with a high degree of precision are available for nominal bonds from the Bond Exchange of South Africa (BESA, 2004). Despite this, the method proposed by Svensson (1994) was used to determine both real and nominal forward rates, because only the nominal rates were available from the BESA, and further extensions of the dataset would have meant periodically requesting further data from the exchange. According to Svensson (1994), his method is adequately precise for the purposes of monetary policy.

⁸The R194, R153, R201, R157, R203, R204 and R186, maturing in February 2007/2008/2009, August 2009/2010/2011, December 2014, September 2014/2015/2016, September 2017, December 2018 and December 2025/2026/2027.

⁹The R198, R189, R197 and R 202, maturing in March 2008, March 2013, December 2023 and December 2033.

¹⁰This was a time consuming and repetitive exercise; therefore a macro was written for Matlab in order to iteratively input the relevant coupon bond data into the programme and collect the forward rates from the programme for each day.

values for these curves. There is concern about the liquidity of the inflation-indexed government bonds. Around a quarter of the observations lost were from 2006, where a sharp increase in the demand for these bonds was not met by supply, and real yields were distorted (BESA, 2006). About half of the lost observations were from the end of 2007 and 2008 when the demand for inflation-indexed bonds was likely to have increased again. Had this been included, the algorithm would have struggled to minimise the large yield errors and plot the curve.

However, the rest of the curves seem reasonable. As predicted by the literature, most of these real forward rate curves were flat at the longer horizons. On visual inspection, the interest rate at which these curves settled also did not fluctuate wildly from observation to observation. Over the entire period, the stable, longer-term portion of the curves varied around 2% to 5%.

Finally, the forward inflation compensation could be calculated for each day by finding the difference between the nominal and real forward rates on that day. For example, the one-year forward inflation compensation (inflation expectations) for the one-year period between four and five years is calculated by subtracting the one-year real forward rate, ending in five years, from the one-year nominal forward rate, ending in five years.

$$InflComp(4 - 5) = NomFwdRate(4 - 5years) - RealFwdRate(4 - 5years) \quad (7)$$

6 Analysing the South African Implied Forward Rates

An analysis of the forward inflation compensation measure extracted in the previous subsection seems appropriate at this point in order to provide insight into the nature of the series created and to consider whether the series is congruent with what we already believe about inflation expectations. Figure IV depicts the correlation between the consumer price index and the forward inflation compensation series ending in one year, five years time and ten years time. The figure depicts that inflation compensation at the one year horizon lay below actual inflation, while it increased sharply around the end of 2002, and then declined to within the inflation targeting band until mid-2007. More crucially, inflation compensation at the five- and ten-year horizons seems to suggest that even in the 2002/2003 period of high inflation, the markets did expect inflation to move back toward the target band in the future. Most striking is the fact that inflation compensation at the ten-year horizon is already anchored within the target band by mid-2002. With regards to the recent period of inflation, the inflation compensation again suggests that the markets expect inflation to progressively move back towards the target band.

Figure IV

The histograms in figure V represent the distribution of forward inflation compensation over the sample period. Forward inflation compensation ending in five years time (the first histogram) centres around a median of 5,57%, varies between a minimum of 4,01% and a maximum of 9,45%, and has a standard deviation of 1,05. In comparison, the forward inflation compensation ending in ten years time is slightly better anchored. It centres around a median of 5,38%, and the observations are bunched a little tighter around this median, with a minimum of 3,96%, a maximum of 9,08% and a standard deviation of 0,84.

Figure V

The autocorrelation and partial autocorrelation coefficients for CPIX and forward inflation compensation in Table I demonstrate the persistence of these measures. These three series were determined at monthly intervals (the first day of each month on which the Treasury Bills are auctioned), so the lags can be interpreted as the number of months that the autocorrelation persists. The CPIX series reflects strong persistence as expected (autocorrelation takes 15 lags to die out). The forward

inflation compensation ending in five years and ten years time illustrate lower levels of persistence. The forward inflation compensation ending in five years time dies out after 9 months, and auto-correlation coefficient of forward inflation compensation ending in ten years time declines below 0,1 within seven months, but this low level of persistence does remain until the fifteenth month.

Table I

7 Risk Premia

The nominal interest rate captures a range of risk premia, with the liquidity risk and inflation risk premia having the greatest influence in this case (Sack (2002), Söderlind (1995), Aron and Muellbauer (2006)). An advantage of using government bonds is that the credit risk is very low (Svensson and Söderlind, 1997). The South African government bond market is sophisticated and has recently been rated the sixth most liquid in the world by the Bank for International Settlements (Bonorchis, 2007).

Aron and Muellbauer (2006) warn that even if liquidity is constant, as the period to maturity of the bond decreases, the inflation risk decreases, which will especially distort our evaluation of inflation expectations over the long-term. Casual inspection of the trends in the spreads between the nominal and real bonds does reveal a slight downward trend, but again this is a variable that changes at a low frequency.

Figure VI

As discussed above, the magnitude of the risk premia and their impact on measures of inflation expectations is highly contentious. In this study, the assumption has been made that the risk premia are not large and they do not change substantially at a daily frequency. Further research which attempts to measure these risk premia would add valuable insight and improve the precision of this inflation compensation series.

8 Conclusion

The expectations channel of the transmission mechanism is central to the implementation of modern monetary policy. A brief review of the current methods used in South Africa to monitor inflation expectations was followed by the presentation of inflation compensation as a new measure which could offer further insight. The lack of forward rate instruments with long maturities traded in the markets meant that implied forward rates had to be calculated. The various methods of extracting implied forward rates from traded bond data were discussed, and the practical calculation of these rates for the South African market was presented.

References

- [1] ANG, A, BEKAERT, G, and WEI, M. 2007. The Term Structure of Real Rates and Expected Inflation. The National Bureau of Economic Research, *Working Paper* No. 12930.
- [2] ANDERSON and SLEATH. 2001. New estimates of the UK real and nominal yield curves. Bank of England, *Working Paper* 126.
- [3] ARON, J and MEULLBAUER, J. 2006. Review of Monetary Policy in South Africa since 1994. *Revised Version of a paper prepared for a joint CSAE_ Stellenbosch University conference: South African Economic Policy Under Democracy: a 10 Year Review*, 27/28 October 2005.

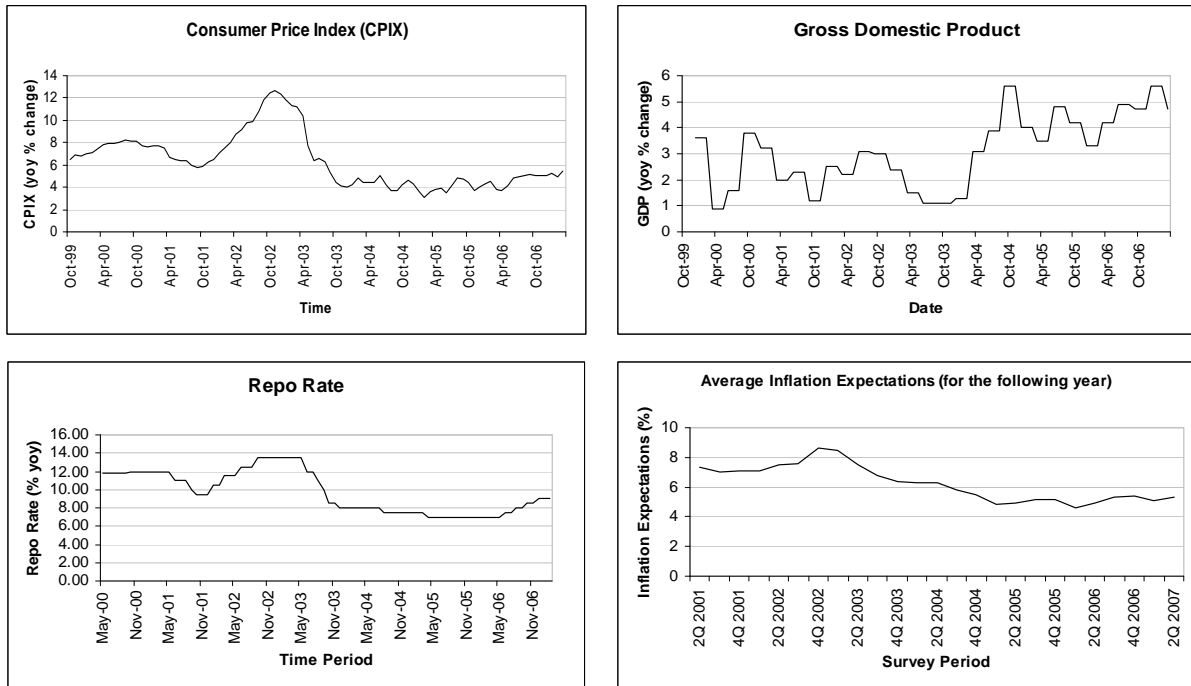
- [4] BANK OF INTERNATIONAL SETTLEMENTS. 2005. Zero-coupon yield curves: technical documentation. Monetary and Economic Department: *BIS Papers* No 25, October 2005.
- [5] BARCLAYS and the BOND EXCHANGE OF SOUTH AFRICA. 2006. *Barclays BESA South African Government Inflation-linked Bond Index: Index Guide*. https://ecommerce.barcap.com/gilbpub/docs/BarclaysBesaSAGovt_IL_Guide.pdf
- [6] BERK, J.M. 1998. The Information Content of the Yield Curve for Monetary Policy: A Survey. *De Economist*, 146 No 2: 303 – 320.
- [7] BOND EXCHANGE OF SOUTH AFRICA. 2004. The BEASSA zero coupon yield curves: a new yield curve standard. http://www.profile.co.za/FMD/Reference_library/2004/besa/FMH04_BESA.htm
- [8] BOND EXCHANGE OF SOUTH AFRICA. 2007. Nominal bond data received by email.
- [9] BONORCHIS, R. 2007. Global bank praises SA bond market. *Business Day*, 10 September 2007: 13.
- [10] COLEMAN, T.S. 1998. Fitting Forward Rates to Market Data – draft. <http://ssrn.com/abstract=994870>
- [11] DIEBOLD, F and LI, C. 2006. Forecasting the term structure of government bonds yields. *Journal of Econometrics*, 130: 337 – 364.
- [12] FISHER, M, NYCHKA, D and ZERVOS, D. 1995. Fitting the term structure of interest rates with smoothing splines. *Finance and Economics Discussion Series*, 95-1, Federal Reserve Board.
- [13] GÜRKAYNACK, R, SACK, B, and SWANSON, E. 2005. The sensitivity of long-term interest rates to economic news: evidence and implications for macroeconomic models. *American Economic Review* 95(1): 425-436.
- [14] KERSHOFF, G. 2000. Conducting Inflation Expectation Surveys in South Africa. Bureau of Economic Research.
- [15] KERSHOFF, G.J. and SMIT, B. 2001. Conducting Inflation Expectation Surveys in South Africa. Presented at the International Jubilee Conference of the Economic Society of South Africa, held 13 and 14 September 2001 at Glenburn Lodge Johannesburg.
- [16] NELSON, C.R. and SIEGEL, A.F. 1987. Parsimonious Modeling of Yield Curves. *Journal of Business*, 60, 473 – 489.
- [17] REUTERS. 2006. Econometer, received by email.
- [18] SACK, B. 2002. A Monetary Policy Rule Based on Nominal and Inflation-Indexed Treasury Yields. Board of Governors of the Federal Reserve System (U.S): *Finance and Economics Discussion Papers*.
- [19] SÖDERLIND, P. 1995. Forward Interest Rates as Indicators of Inflation Expectations. Address: Institute for International Economic Studies, Stockholm University, 28 May 1995.
- [20] SÖDERLIND, P. 2007. Paul Söderlind’s Research. <http://home.datacomm.ch/paulsoderlind/>
- [21] SOUTH AFRICAN RESERVE BANK. 2001 – 2007. *South African Reserve Bank Quarterly Bulletin*, various issues.
- [22] SOUTH AFRICAN RESERVE BANK. 2007. Statistical and Economic Information. <http://www.reservebank.co.za>

- [23] SOUTH AFRICAN RESERVE BANK ACT 90 of 1989, amended.
<http://www.reservebank.co.za>
- [24] STATSSA. 2007. Statistical Publications.<http://www.statssa.gov.za/publications/findpublication.asp>
- [25] SVENSSON, L.E.O. 1994. Estimating and Interpreting Forward Interest Rates: Sweden 1992 – 1994. National Bureau of Economic Research, *Working Paper* No. 4871.
- [26] SVENSSON, L, and SÖDERLIND, P. 1997. New Techniques to Extract Market Expectations from Financial Instruments. *Journal of Monetary Economics*, 40, 383-429.
- [27] WAGGONER, D.F. 1997. Spline Methods for Extracting Interest Rates Curves from Coupon Bond Prices. Federal Reserve Bank of Atlanta, *Working Paper* 97-10.
- [28] WALSH, C. E. 2003. *Monetary Theory and Policy*. Second Edition. Cambridge: MIT Press.

Table I: Autocorrelation and partial autocorrelation (May 2002-June 2008)

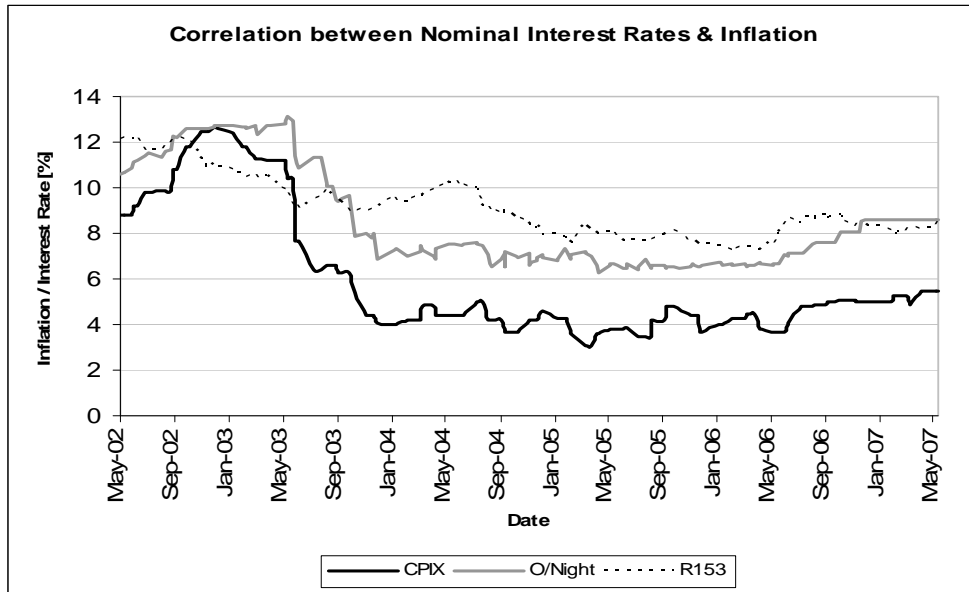
| Lags | CPIX | | Forward Inflation compensation ending in five years | | Forward Inflation compensation ending in ten years | |
|------|--------|--------|---|--------|--|--------|
| | AC | PAC | AC | PAC | AC | PAC |
| 1 | 0.932 | 0.932 | 0.826 | 0.826 | 0.707 | 0.707 |
| 2 | 0.857 | -0.084 | 0.703 | 0.069 | 0.528 | 0.055 |
| 3 | 0.790 | 0.020 | 0.570 | -0.086 | 0.357 | -0.069 |
| 4 | 0.732 | 0.030 | 0.450 | -0.049 | 0.258 | 0.026 |
| 5 | 0.664 | -0.115 | 0.361 | 0.025 | 0.155 | -0.053 |
| 6 | 0.581 | -0.144 | 0.304 | 0.058 | 0.135 | 0.081 |
| 7 | 0.495 | -0.071 | 0.216 | -0.127 | 0.092 | -0.028 |
| 8 | 0.415 | -0.029 | 0.130 | -0.090 | 0.063 | -0.017 |
| 9 | 0.346 | 0.015 | 0.043 | -0.063 | 0.090 | 0.108 |
| 10 | 0.279 | -0.020 | -0.009 | 0.045 | 0.048 | -0.102 |
| 11 | 0.209 | -0.057 | -0.046 | 0.010 | 0.059 | 0.067 |
| 12 | 0.144 | -0.009 | -0.050 | 0.041 | 0.048 | -0.009 |
| 13 | 0.098 | 0.078 | -0.045 | 0.021 | 0.051 | 0.002 |
| 14 | 0.065 | 0.035 | -0.039 | 0.009 | 0.004 | -0.055 |
| 15 | 0.032 | -0.037 | -0.034 | 0.008 | 0.006 | 0.012 |
| 16 | -0.009 | -0.078 | -0.019 | 0.026 | -0.035 | -0.049 |

Figure 1: Macroeconomic Trends



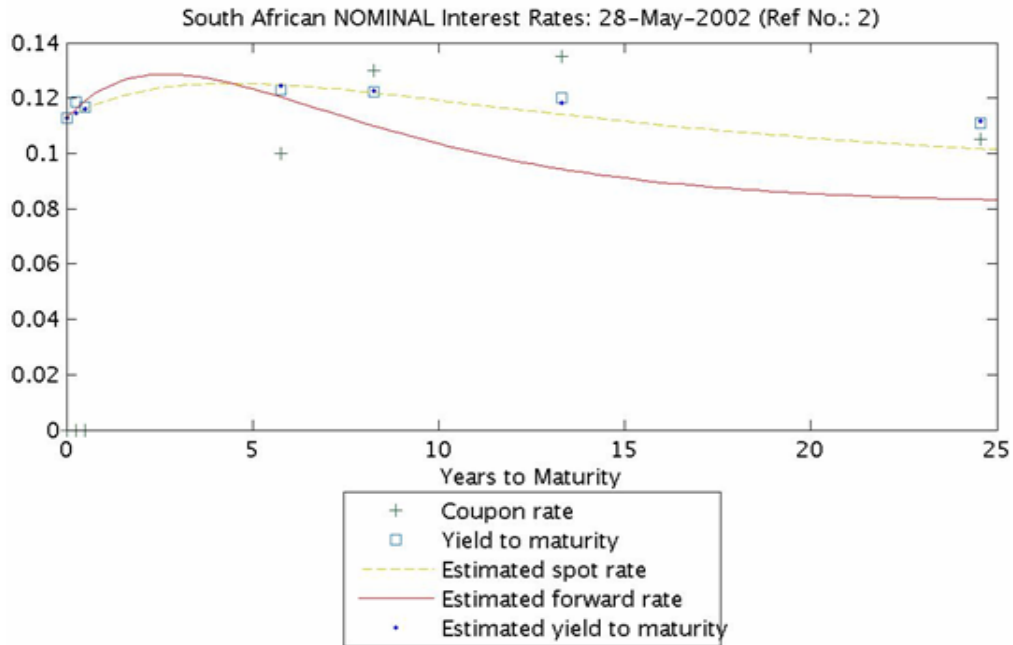
Sources: CPIX and GDP data from Stats SA
 Inflation expectations data from the BER
 The repo rate from the SARB

Figure II: Correlation between nominal interest rates and inflation



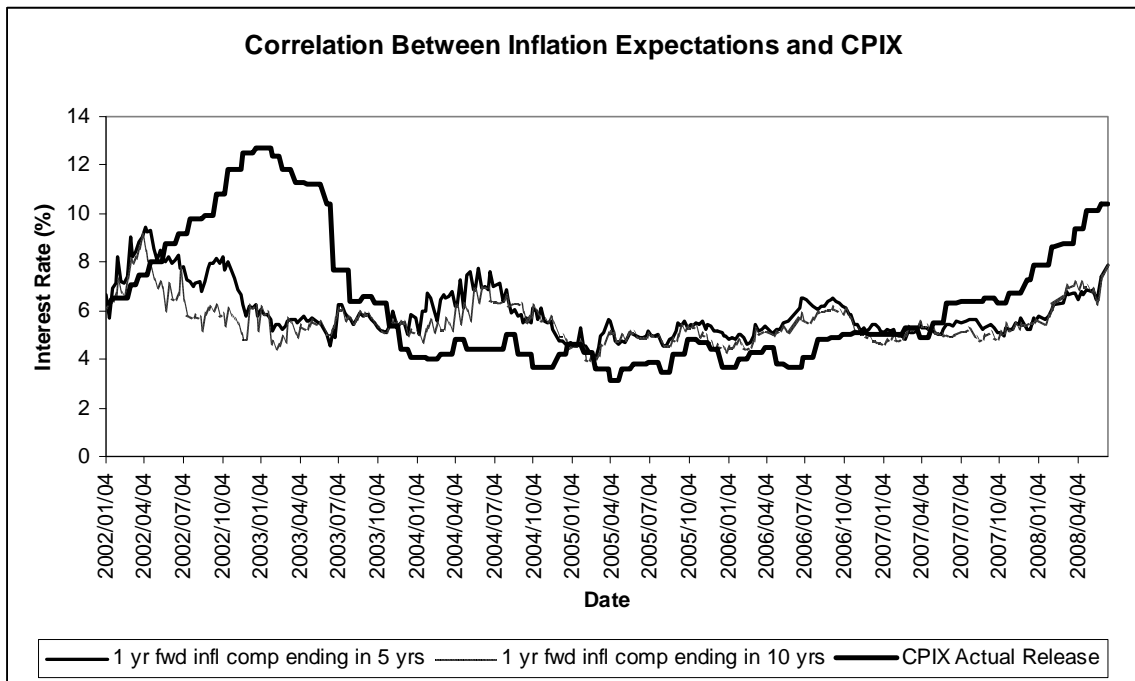
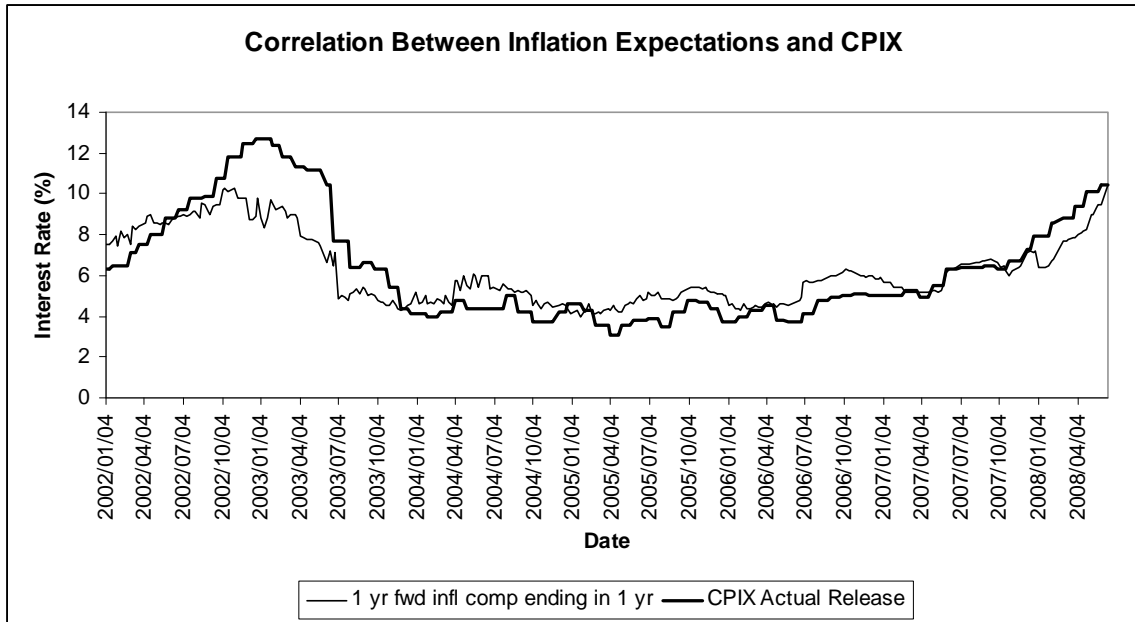
Source: SARB Quarterly Bulletins, issues 2002-2007 (CPIX)
 SARB (overnight rate)
 BESA (R153)

Figure III: South African Nominal interest rates: May 2002



Source: Results calculated for SA data, using Matlab programme by Söderlind.

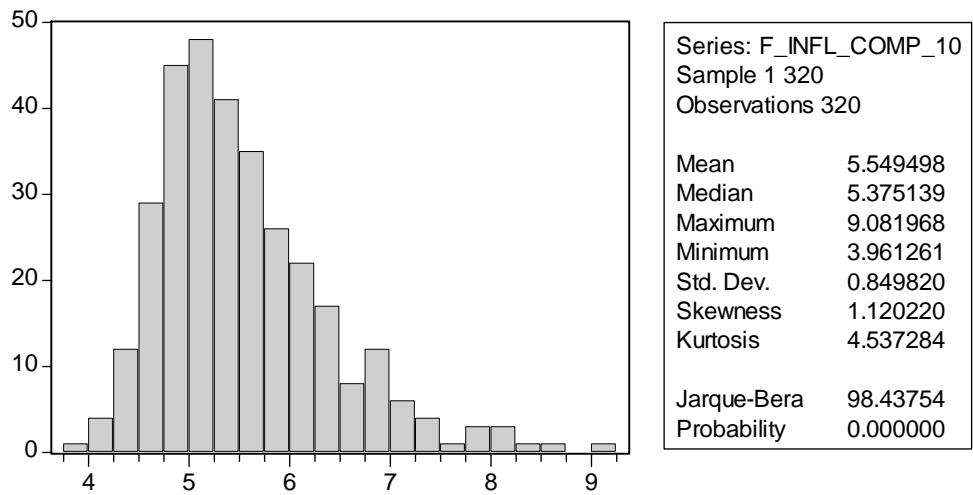
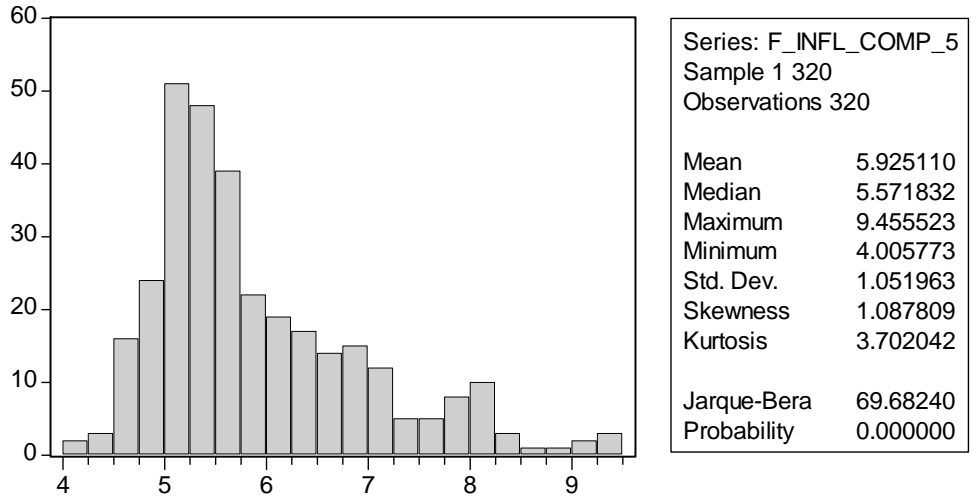
Figure IV: Correlation between inflation expectations and CPIX



Sources: Data from the SARB

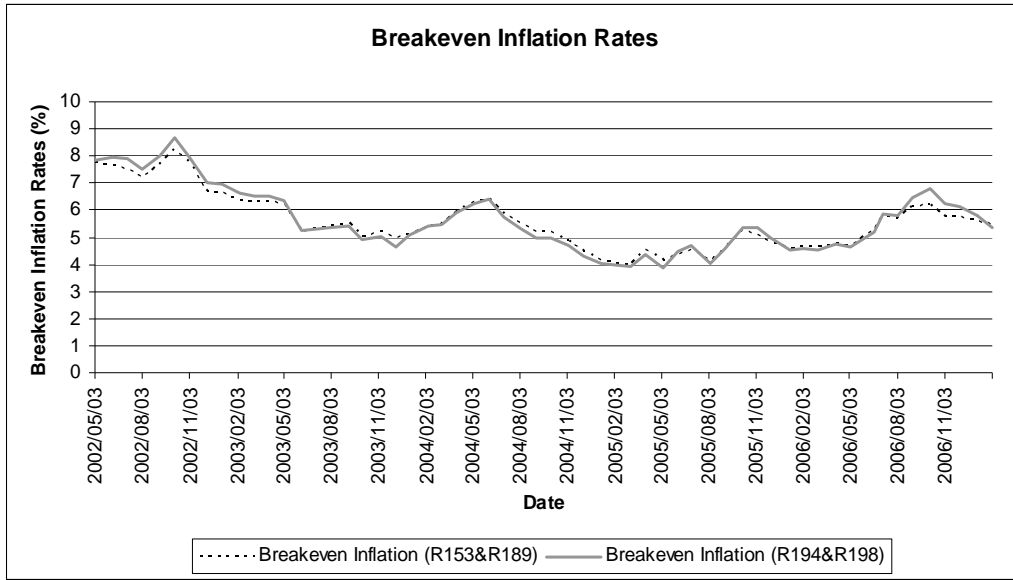
Own calculations

Figure V: Distribution of forward inflation compensation (May 2002 – June 2008)



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Figure VI: Breakeven inflation rates



Source: Bond yield data provided by BESA